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Resemblance of *Atmospheric, Magnetic and Oceanic Currents.*

By Pliny Earle Chase.

(*Read before the American Philosophical Society, April* 7, 1871.)

My belief that terrestial magnetism is dependent solely upon fluid currents, electrified by convection and by the condensation of vapor, led me to look for some confirmation of my views in the results of my recent discussions of the winds of the United States. My attention was first drawn to the resemblance between the looped isogonic lines in the eastern equatorial portion of the Pacific Ocean, and the anti-cyclonic course of the winds in the Gulf States. The undoubted rapidity of magnetic action, a rapidity analogous to, if not identical with, that of luminiferous vibrations, renders it probable that the flexure of the isogonic lines, at any given point, may be determined by the resultant of all the forces acting at that point, and that the equatorial loops are, therefore, expressions of equatorial disturbance.

If the same disturbance is communicated to the more sluggish air, its culmination may naturally be sought at some point northward and eastward, because of the well-known laws of current deflection. The principal thermal contrasts which contribute to the establishment of currents, are: 1st, land and water; 2d, polar and equatorial; 3d, heat and cold at isabnormal centres. It seems reasonable to suppose that these triple contrasts should be so mutually related, that there may be some system of rectangular coördinate planes which would present each of them as a maximum.

A great circle cutting the equator on the meridians of 100° W. and 80° E., and passing through the geographic centre of the land hemisphere, follows the general trend of the American coast from Florida to Newfoundland, skirts the equatorial isogonic and the Florida atmospheric loops, finds the western limit of our anti-cyclonic system of winds at a point about midway between the magnetic pole and the equator, and crosses the equator on the meridians and near the centres of greatest Horizontal Force. A co-ordinate great circle following the meridians of 10° W. and 170° E., intersects the magnetic equator of minimum intensity near its greatest northern and southern elongations. The third co-ordinate great circle corresponds very nearly with the dividing plane between the land and water hemispheres. The principal north pole of declination and the Asiatic equatorial intersection of the line of no variation, are on the meridians first named, which traverse the intersections of the first and third co-ordinate circles. A great circle intersecting the second co-ordinate on the equator, and passing near the North American pole of declination, would cut the first of these meridians (100° W.) at an angular distance from the pole analogous to that of the Florida wind loop from the equator, traversing the principal isogonic loops in such manner as to exhibit the magnetic symmetry of the entire globe to the best advantage. No other system of rectangular co-ordinate planes would meet with so little land interruption, or would divide the globe into hemispheres with so great current-producing contrasts.

An observer, therefore, near the centre of the land hemisphere, would find, at the four cardinal points of his true horizon, magnetic, thermal and geographic positions of peculiar importance, and indicative of interesting mutual relations. The recognition of such relations gives a new interest to the often noticed resemblance between the isoclinal and isothermal lines, the analogy which I have myself pointed out between the isogonic and cotidal lines, the parallelism of the boundary lines and of the axis of the westerly isogonic belt with the boundaries of the corresponding annual isabnormal belt, the isogonic curvatures in or about regions of isabnormal heat or cold, the different angular relations of the isogonic lines to the customary paths of hurricanes and storms, and the approximate perpendicularity of direction and opposition of curvature between the westerly wind belt and the isogons. All of these features, which may be satisfactorily explained by the general principles on which storm laws are based, furnish cumulative, if not irresistible, evidence of the dependence of magnetic currents upon the same laws of gravitation, which tend to restore the equilibrium of air and sea, after tidal or thermal disturbances. The evidence is sustained not only in the general distribution of the magnetic lines, but also in their particular details, the course of the isogonic lines, *at every point*, being an evident resultant of the combined equilibrating tendencies between land and water, and between centres of normal and isabnormal heat and cold.

The ocean currents corroborate the gravitation theory of magnetism, perhaps even more strongly than the wind belt. A physical atlas like Petermann's, which marks the most rapid portions of the several currents with the deepest tints, shows their relation to the magnetic and coast lines very satisfactorily. A comparison of the more minute details exhibits additional interesting evidence that the original impulse of all terrestial currents, atmospheric, magnetic and oceanic, is given by luminous, thermal or tidal disturbances, that the currents are maintained by gravity in its continual tendencies to restore the continually disturbed equilibrium, that the magnetic currents are least, while the ocean currents are most interrupted and modified by land contours, that each of the more sluggish currents exerts a secondary modifying influence on the more rapid, that extraordinary variations in thermal or luminous undulations, whether originating at the sun or at the earth, produce "magnetic storms," and that, whatever theory may be adopted as to the mode in which the solar undulations are transmitted, there is no philosophical necessity for the hypothesis of any cosmical origin or disturbance of terrestrial magnetism other than variations in the amount of light and heat received and in the directions of gravitating tidal and equilibrating lines.*

* It is so difficult to make the necessary allowances for the distortions of the ordinary magnetic charts, that I would recommend any one, who may desire to make the comparisons which I have suggested, to trace the lines on a globe. A slate globe is especially satisfactory. The data for my own comparisons were taken from the lines of equal magnetic variation and of equal horizontal force for 1860, in the 2d edition of the "Admiralty Manual for ascertaining and applying the deviations of a compass, caused by the iron in a ship." Walker's "Terrestial and Cosmical Magnetism;" Coffin's "Winds of the Northern Hemisphere;" Dove's "Isothermal and Isabnormal charts," "Petermann's and Johnston's Physical Atlases." In order to judge of the resultant influences of the normal and isabnormal thermal disturbances, it will be well to mark the *centres* of isabnormal heat and cold, as well as the points of greatest average heat and cold.

Mr. Walker, in his Adams Prize Essay for 1865, p. 268, says: "it is worthy of remark that the portion of the year when the magnetic force is the greatest, and the direction of the needle most vertical in *both* hemispheres, coincides with that at which the earth is nearest to the sun and moves with the greatest velocity in its orbit. This fact furnishes another argument against the theory that these effects are due to *temperature*, as in that case they ought to occur at *opposite* periods of the year in the two hemispheres, whereas in fact they occur at the same period in both." The writer was doubtless misled by the annual variations in declination and horizontal force, which are evidently dependent upon the relative temperature of the northern and southern hemispheres. But if all the magnetic effects are primarily due to thermal and gravitating motion, it is evident that the *total* magnetic force must depend upon the *total* current producing energy of the sun, which is, of course, a maximum when "the earth is nearest the sun, and moves with the greatest velocity in its orbit." The argument which was considered conclusive against the theory, is, therefore, wholly in its favor.

THE CAUSES OF *Regional Elevations and Subsidences*, by LIEUT. C. E. DUTTON.

(*Read before the American Philosophical Society, April* 7, 1871.)

Lieut. C. E. Dutton, desired to submit certain views, which he had been led to entertain, respecting the causes of regional elevations and subsidences. He was unacquainted with any views on this subject in the writings of geologists, which seemed to be satisfactory. In reflecting upon the nature of metamorphic rocks, and the probable changes which they had undergone, he thought that the facts brought to light by the researches of Bischoff, Daubrée, Sorby, Sterry-Hunt and others in that field, might contain, also, a solution of the unexplained problem of elevations and subsidences. It is now a generally accepted opinion among writers upon chemical geology, that metamorphic rocks have reached their present condition, through the combined agencies of heat, pressure, and water, acting upon sedimentary strata; that sulphur, carbonic acid and volatile chlorides and fluorides have played highly important parts under similar conditions, and that soluble earths and metallic salts and vapors have had no inconsiderable influence upon the totality of changes. That water especially, under the influence of a moderately high temperature and great pressure, is capable of changing in a wonderful manner the structure and arrangement of rocky materials of all kinds, has been abundantly shown by innumerable synthetical experiments, a great number of which have been summed up by Daubrée in an able memoir on the subject to the French Academy. He has also shown that minerals, which,